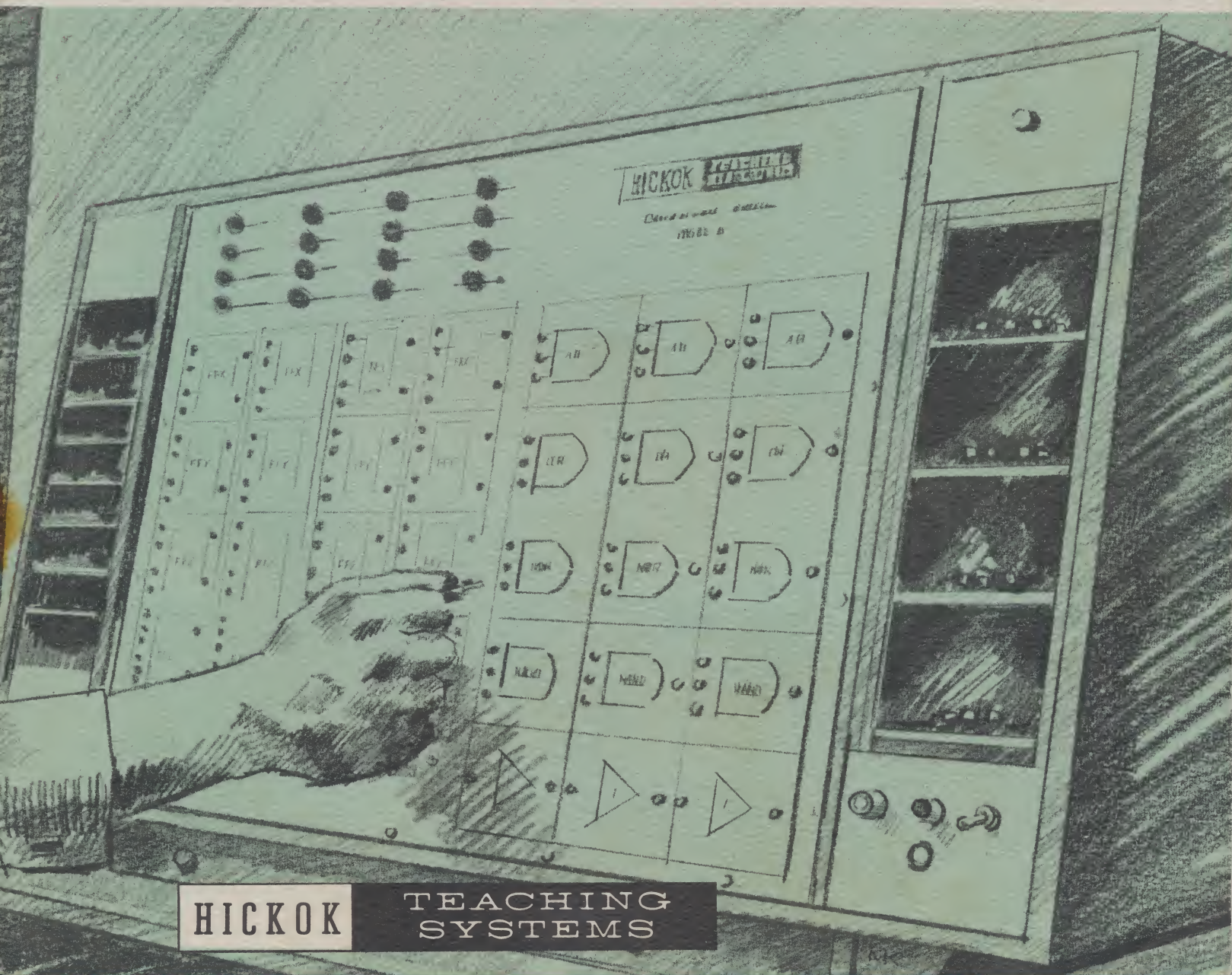


*unified course for teaching*

## DIGITAL COMPUTER FUNDAMENTALS

*complete course including actual equipment/laboratory and text materials/instructor's guide /teaching aids*





# INTRODUCTION

In little more than a decade, digital computer technology has mushroomed; practical applications of digital computers are found across the spectrum of science, education, industry, military, and the more exotic challenges extending into outer space. With this rapid growth has come a demand for technically proficient support personnel capable of operating and maintaining complex digital computing equipment without major on-site training.

Technical schools and colleges have already begun to institute courses to meet this growing demand. Industry and military standards have been formulated to provide guidelines. Hickok Teaching Systems, Inc., is the first to offer a *unified* course to provide the instructor all the materials needed to institute a sound program in *Digital Computer Fundamentals*.

The basic principles of modern computing devices are made far simpler when the student performs a set of specially selected experiments coordinated with the text which lead him from basic fundamentals to the actual operating characteristics of computers. The Hickok Model 70 Computer Trainer, designed for use with this course, provides a means of visualizing the theory. In effect, the student learns by doing. Once the theory is mastered, understanding of any particular machine is straightforward. Thus, students who have taken the course are well qualified to help fill the tremendous demand for computer technicians that exists today.

*Digital Computer Fundamentals* is designed to prepare students for work in the computer field by developing a comprehensive understanding of digital computer theory and practice. Students should have an understanding of some algebra and a little knowledge of transistors. Through classroom demonstration and student experiments, a solid base of theory balanced by practical skill is achieved.

The textbook and laboratory manual used in the course were developed by Thomas C. Bartee of Harvard University, an advisor to NATO and the Air

Force on digital computers. The text is used at all three U. S. Military academies and at such other leading institutions as Purdue, Princeton, University of California, and the IBM Corporation.

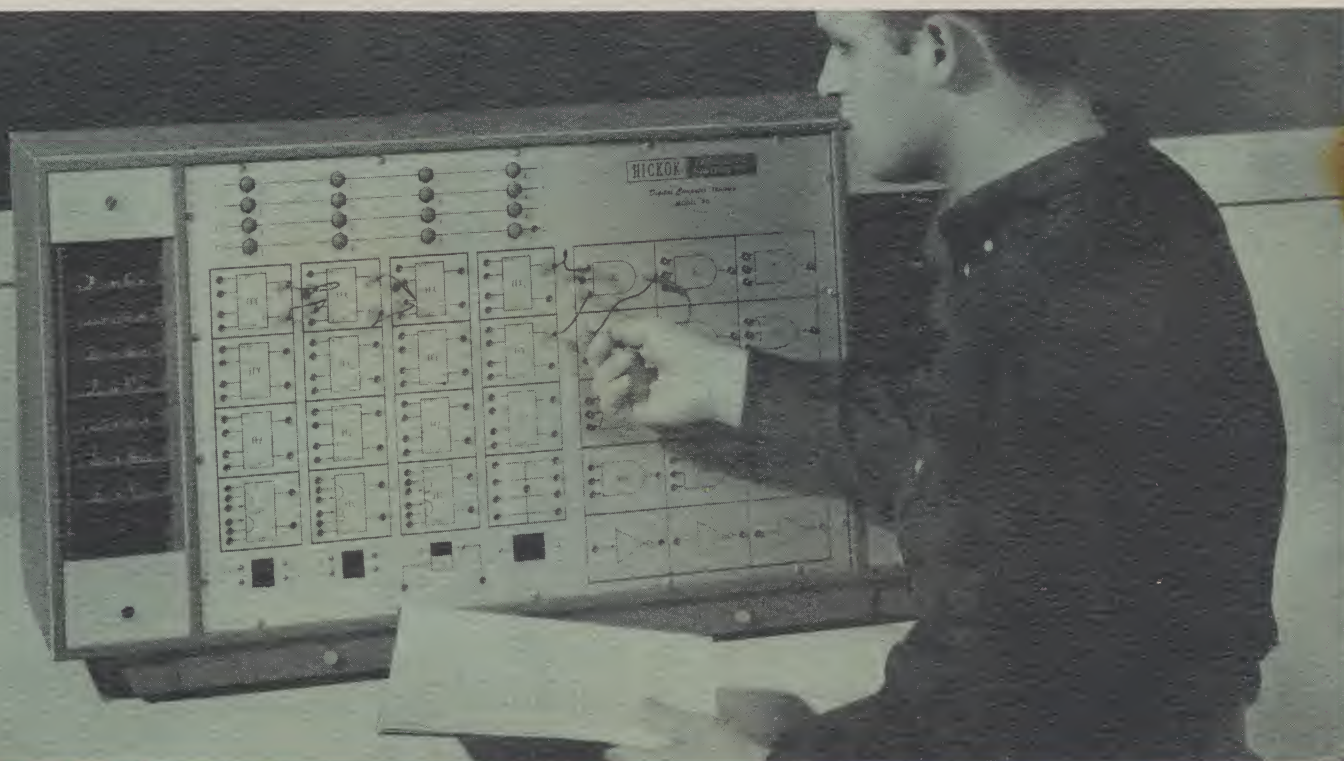
The experiments which accompany the text are arranged in a logical sequence. Once introduced, a concept is not dropped, but is applied with increased complexity along with new concepts introduced in subsequent experiments. *The emphasis of the manual is on teaching the fundamental simplicity of computer logic and circuits.*

Basic to the instructor's effectiveness are the teacher aids supplied by Hickok Teaching Systems, including the teacher's guide and answer book, reference texts, and a series of six color films. Teachers are also given an opportunity to attend regularly held in-service workshops designed to provide technical background information as well as the latest techniques for presenting new concepts.

The Hickok Model 70 Computer Trainer is required laboratory equipment for teaching *Digital Computer Fundamentals* and has been designed and built by Hickok for extremely reliable operation.

The digital computer trainer is housed in a portable, lightweight metal cabinet with built-in power supply. Computer functions are all solid-state circuitry. Symbology is MIL SPEC and American Standard with an overlay for teaching IBM symbols. The trainer is designed to operate at four speeds in order to provide for maximum student learning. Students set up experiments by wiring functions on the patch-board face of the trainer. School laboratories should be provided with one trainer to serve teams of two students, plus one unit for instructor demonstration.

The Hickok Course in *Digital Computer Fundamentals* is designed to meet standards set by the computer industry, the present and future demands for increased numbers of skilled technicians, and your requirements for a sound school program.





# COURSE MATERIAL

The textbook selected for the Hickok course is *Digital Computer Fundamentals* by Thomas C. Bartee, published by the McGraw-Hill Book Company and used in more than 100 schools and colleges. The text provides a thorough introduction to the digital computer. The function of a computer is described in terms of both theory and application, with an explanation of the latest electronic computer circuitry. It is assumed that the student has an understanding of basic electronics that would be covered in a course in electronic fundamentals and a knowledge of elementary algebra.

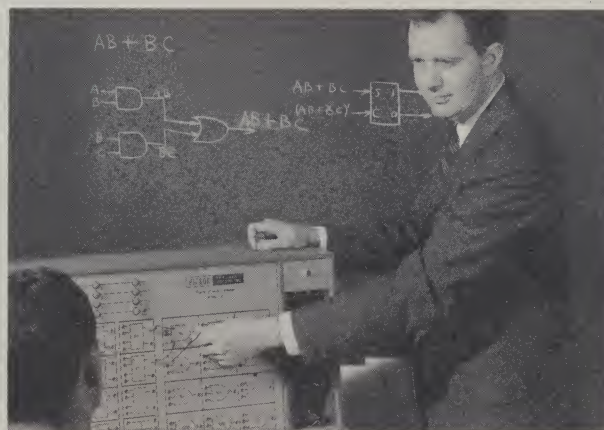
The book does not concentrate on a single area; but rather deals with the fundamentals of digital computers in introductory language, yet the student progresses in modular stages through a comprehensive body of computer technology.

*Digital Computer Fundamentals* may be divided into three major sections: (1) The applications of digital computers in business, industrial and scientific organizations, including an introduction to computer programming. (2) A consideration of computer number systems, primarily binary and binary-coded-decimal; computer circuitry, with emphasis on transistor and diode switching; and fundamental logical design, with an introduction to Boolean algebra and the use of block diagrams. (3) Study of the major elements of a digital computer; the arithmetic unit, memory element, input-output devices, and the control element.

This text has been widely acclaimed by students and instructors, and represents a compilation of knowledge by one of the world's leading authorities on the subject presented for the purpose of building a foundation of knowledge for the beginning computer technology student.

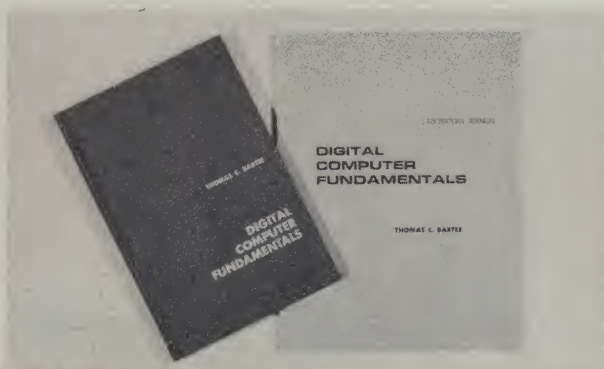
## Outstanding features of the text

- Early description of switching circuits and logical algebra prepares students for subsequent material.
- Early presentation of "register" and definition of "transformation of a register's contents" and "operations between registers" makes material easier to understand than many other texts.
- Among recent advances described are: transistor switching circuits; thin-film memories; very high-speed tape mechanisms; character recognition; parallel control elements; direct-coupled transistor logic.
- Review questions and references for each chapter. A complete instructor's answer booklet is provided for both text and laboratory manual.



THOMAS C. BARTEE is presently teaching a course on computers at Harvard University. For eight years, he has worked at the Massachusetts Institute of Technology, Lincoln Laboratory as a digital machine designer. He has designed communication system computers, high-speed digital computers for radar tracking, and commercial digital computer systems; is a consultant to the Air Force Institute for Defense Analysis, Raytheon Company, McGraw-Hill Book Company; member of the NSF National Committee on Applied Mathematics and the International Committee on Applied Mathematics.

| Subject                       | Laboratory Manual                           | No. of Experiments | Est. Lab. Time |
|-------------------------------|---|--------------------|----------------|
| Digital Computer Fundamentals | Digital Computer Fundamentals, Bartee, 1964 | 25                 | 40-60 hours    |



In addition to *Digital Computer Fundamentals*, Bartee has co-authored two texts in the digital engineering field published by McGraw-Hill, has contributed the electronic digital computer portion of the McGraw-Hill Textbook on Modern Engineering; and is an editor of the IEEE publication on electronic computers.



## COURSE OBJECTIVES

1. Treat the principles of modern digital computers.
2. Introduce the number system used in digital machines: binary numbers and binary-coded-decimal numbers.
3. Introduce mathematical material used in working with digital computers: Boolean algebra, the calculus of propositions, switching theory.
4. Explain basic logic units used in modern computing systems: flip-flops, AND gates, OR gates, Inverters, etc.
5. Show how digital machines add, subtract, and perform other arithmetic and logical operations.
6. Demonstrate the principles of pulse and digital circuits, using experiments where students construct actual circuits used in present-day computers and see how they operate, using the Hickok Computer Trainer.
6. Binary Counters
7. NOR Gates and NAND Gates
8. Boolean Algebra
9. The Correspondence Between Boolean Algebra Expressions and Gating Networks
10. Binary Addition
11. Binary Subtraction
12. Binary-Coded-Decimal Numbers
13. Transistor and Diode Fundamentals
14. Basic Waveforms in Digital Machines
15. Diode AND Gates and OR Gates
16. The Transistor Inverter
17. NOR Gates and NAND Gates Using Transistors
18. Transistor Flip-Flops
19. Clock Pulses and Multivibrators
20. Pulsed and DC Logic Systems
21. Resistor-Transistor Logic
22. Direct-Coupled Logic Circuits
23. Binary Multiplication and Division
24. Control Logic
25. Operation Counters

## LIST OF EXPERIMENTS

1. Binary Numbers
2. Basic Storage Devices
3. Shift Registers
4. AND Gates, OR Gates and Inverters
5. Combinational Networks

## WHAT OUTSTANDING EDUCATORS SAY ABOUT THE TEXT

"Each chapter ends with a set of questions and a list of references. Diagrams are numerous and clearly drawn. The amount of information imparted concerning computers in little more than 300 pages is very great; this text fills a real gap, and will certainly be found extremely useful."

"This book is one of the best texts ever written for technical schools."

"Bartee's *Digital Computer Fundamentals* gives a very well balanced coverage of computer arith-

metic and basic computer circuitry. This is essential in a survey course on computers."

"Bartee's *Digital Computer Fundamentals* provides a better understanding of what goes on behind the panel of the computer. This would be of real value to students who are aspiring to become computer technicians."

"*Digital Computer Fundamentals* by Bartee is the best one on computers we have had an opportunity to review. It comes the closest to the method of presentation that we are after of all the books of its kind on the market."

## LIST OF TEXT USERS

Alabama University  
Bakersfield College  
Compton College  
Long Beach City College  
Orange Coast College  
Fullerton Junior College  
Long Beach State College  
East Los Angeles College  
Los Angeles City College  
San Diego Junior College  
Los Angeles Pierce College  
Denver University  
University of Florida  
Dade County Junior College  
Idaho State College  
Fenn College  
Purdue University  
Annapolis  
West Point  
U. S. Air Force Academy  
University of Minnesota  
University of Cincinnati  
Central Oregon College  
Utah University  
William and Mary College

State College of Washington  
University of Maryland State College  
Los Angeles Valley College  
Chico State College  
Boise Junior College  
Northeastern University  
San Jose State College  
Princeton University  
University of California  
Lowell Institute of Technology  
University of Missouri  
Washington University  
Los Angeles Trade-Technical College  
DeVry Technical Institute  
North American Technical Institute  
Mohawk Valley Technical Institute  
Salt Lake School of Electronics  
Milwaukee School of Engineering  
RCA Institutes  
Capitol Radio Engineering Institute  
Radio Institute, Inc.  
State Technical Institute (Conn.)  
Central Technical Institute  
St. Paul Vocational-Adult School  
Industrial Education Centers (N.C.)  
Philadelphia Wireless Institute  
Spring Garden Institute  
Brown Institute of Electronics

Salem Co. Vocational-Technical Institute  
Rocky Mountain Technical Institute  
Delgado Trades Technical Institute  
Dunwoody Industrial Institute  
Minneapolis Vocational Evening School  
State Vocational Technical School  
(Fitzgerald, Ga.)  
Vocational & Technical School  
(Athens, Ga.)  
New York Institute of Technology  
Gaston Technical Institute  
Tennessee Institute of Electronics  
General Electric Company  
IBM Corporation  
Teletype Corporation  
Minneapolis-Honeywell Co.  
Radio Corporation of America  
Western Electric Company  
U. S. Air Defense School  
U. S. Navy  
U. S. Army Signal School  
(Ft. Monmouth)  
Philco Corporation  
The Martin Company  
General Motors  
Westinghouse



# TEACHER AIDS

Hickok TeacherAids have been carefully selected to augment the text and laboratory equipment to give the instructor a source of course content, organization, and testing. Three different types of teacher aids are offered: (1) Comprehensive Instructor's Guide by Bartee, with suggested time allotments and indications of emphasis. (2) Six 16 MM films available to demonstrate principles of digital computer technology. (3) In-service workshops and institutes to provide a continuing source of experience and knowledge for the instructor.

This outstanding new 16 MM color film series is particularly useful in assisting instructors in demonstrating difficult concepts to classes.

1. **DIGITAL COMPUTER FUNDAMENTALS: INTRODUCTION** (16 min., color, 16 MM, No. HB 8969-A, \$175.00) Provides a general introduction to digital computers; explains the historical origins of calculating devices; points out the difference between analog and digital computers, discussing the principal steps involved in the solution of problems subjected to the digital computing process.
2. **DIGITAL COMPUTER FUNDAMENTALS: COMPUTER LOGIC** (13 min., color, 16 MM, No. HB 8969-B, \$140.00) Explains by means of animation the binary number system, defines the several meanings of logic as applied to computers, shows the difference between the decimal and binary number systems, explains how binary

numbers are constructed and how arithmetical operations are performed with them. Cites examples of code variations of the binary system.

3. **DIGITAL COMPUTER FUNDAMENTALS: COMPUTER LOGIC SYMBOLOGY** (15 min., color, 16 MM, No. HB 8969C, \$155.00) Shows the basic Military and American standard symbols of the logic elements of computers as an introduction to digital computer logic symbology; shows their function in electronic signals.
4. **DIGITAL COMPUTER FUNDAMENTALS: COMPUTER UNITS** (24 min., color, 16 MM, No. HB 8969D, \$225.00) Discusses in an introductory way the major units of a digital computer; input, output, arithmetic, and control.
5. **DIGITAL COMPUTER FUNDAMENTALS: LOGIC ELEMENT CIRCUITS** (16 min., color, 16 MM, No. HB 8969E, \$150.00) Illustrates how solid state electronics are used in modern computers.
6. **DIGITAL COMPUTER FUNDAMENTALS: PROGRAMMING** (14 min., color, 16 MM, No. HB 8969F, \$150.00) Defines computer programming, explains what is meant by analyzing the problem, shows how a simple flow chart is prepared with symbols giving their meaning, and shows by use of a simple example how instructions to the computer are encoded in computer language.





# DIGITAL COMPUTER TRAINER

The Hickok Model 70 Digital Computer Trainer is a compact, portable demonstration and experimentation unit designed to offer realistic practice with digital logic circuits. The entire face of the unit is composed of MIL SPEC and American Standard logic symbology — students complete experiments by interwiring the symbols with Hickok FAST JACS™ to create a connection between course theory and computer application. An IBM symbol overlay is included to facilitate an understanding of other logic symbols common in the industry.

The Model 70 is more than a work board — actual functions are accomplished in a choice of four running speeds. All logic circuits are solid state with built-in power supply.

In addition, students can construct circuits using the Hickok breadboarding system with FAST CLIP™ leads on a styrene mounting board provided for this purpose. These breadboarded circuits can then be plugged directly into the computer so the student can see how they operate.

## SPECIFICATIONS

**Controls:** Four speeds — single step, 1 cps, 5 cps, 10,000 cps; start switch, stop input, set switch; fused power on-off switch.

**Logic Panels:** Two interchangeable logic panels; one with MIL SPEC and American Standard symbols, one with IBM symbols; panel contains 151 inputs for interconnecting logical elements.

**Indicator Panel:** 16 neon lamps for visual display plus special indicator light to connect selected logical circuit outputs.

**Circuitry:** All circuits are solid state, mounted on modern printed circuit boards.

**Logic Functions:** (stored behind plexiglass panels) 16 flip-flops; 3 AND Gates; 3 OR Gates; 3 NOR Gates; 3 NAND Gates; 3 Inverters; 1 Multivibrator clock with manually controlled speed; 1 Power Supply.

**Connectors:** 40 leads with rugged stacking-type FAST JACS™.

**Breadboarding Equipment:** The following mounted components are contained in storage tray: 6 transistors; 3 tubular capacitors; 6 mica capacitors; 20 resistors; 12 diodes; 1 styrene mounting board; 1 silk screened storage board; 40 Fast Clip™ Connectors; 1 12-pin connector cable for connections from breadboard to computer trainer.

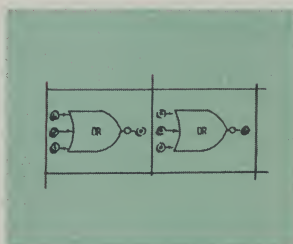
**Power Requirements:** 115 V, 60 cps AC.

**Size:** Length 36", Height 19", Depth 11", Weight 28 lbs.

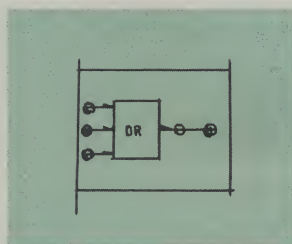
**Manuals:** One comprehensive instructor's manual by Bartee and one student **Digital Computer Fundamentals** laboratory manual by Bartee included with each unit. Additional manuals available on request.

**Price:** \$1,195.00 f.o.b. Cambridge, Massachusetts.

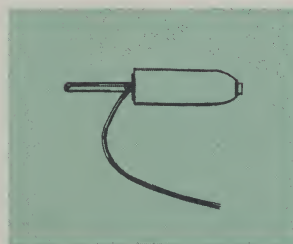
**Recommended Quantity:** One unit for two students, plus one unit for instructor demonstration.



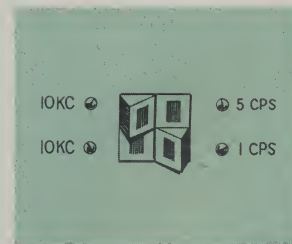
*MIL Gate Symbol — large, easily-read symbols etched on aluminum panels.*



*IBM Gate Symbol—overlay provided for learning IBM symbols.*

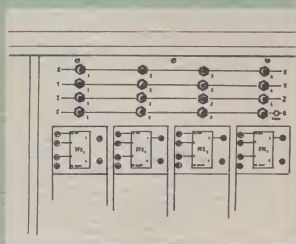
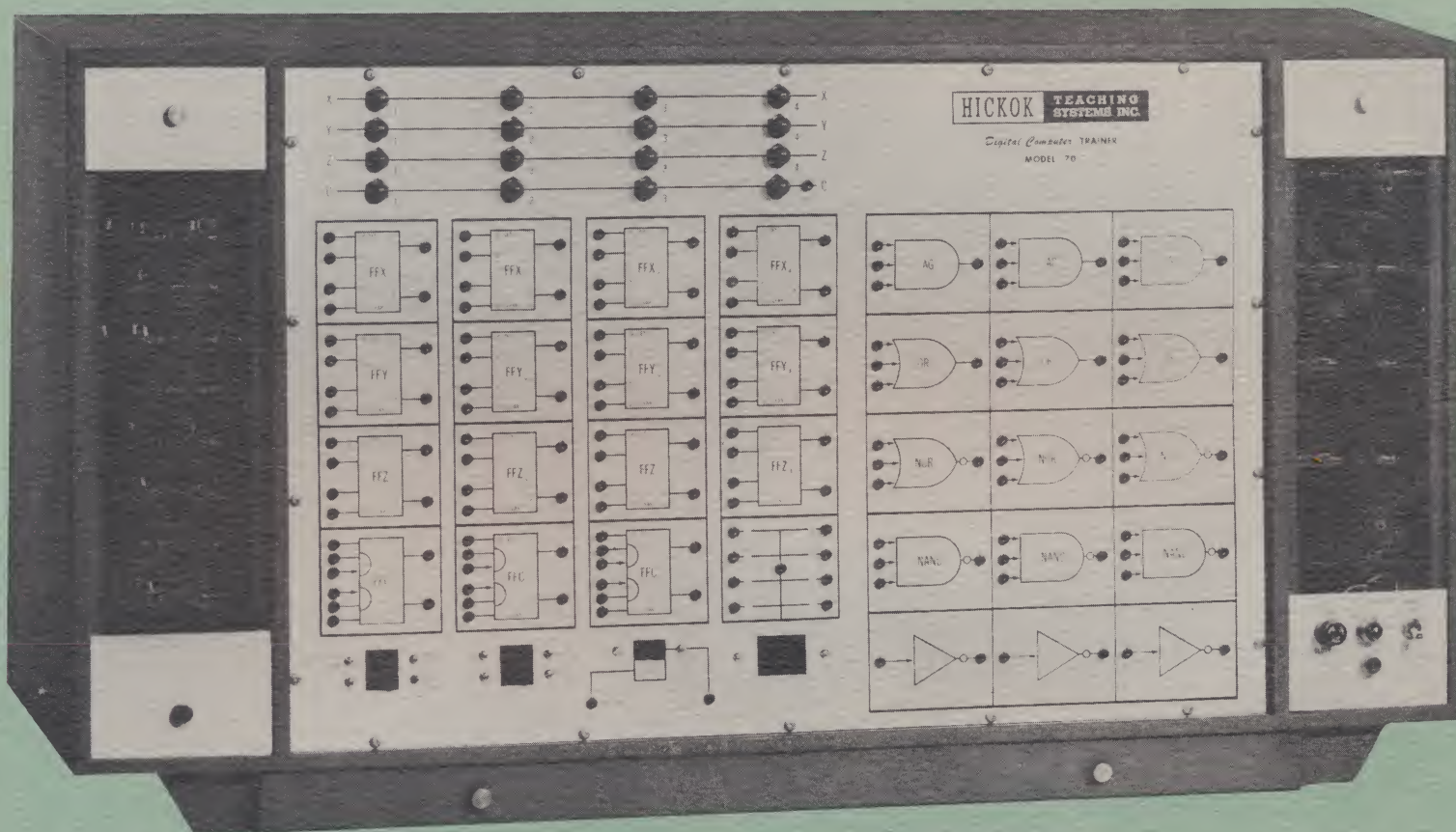


*Stacking FAST JAC™ leads make it easy to interconnect functions.*

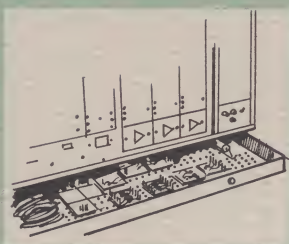


*Four Speed Controls allow students to observe operations at different speeds.*

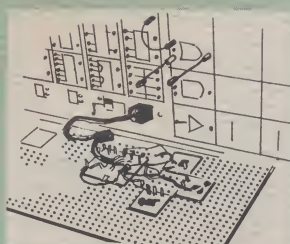




Indicator Lights provided for students to see results.



Storage Tray included for storage of mounted components and connectors.



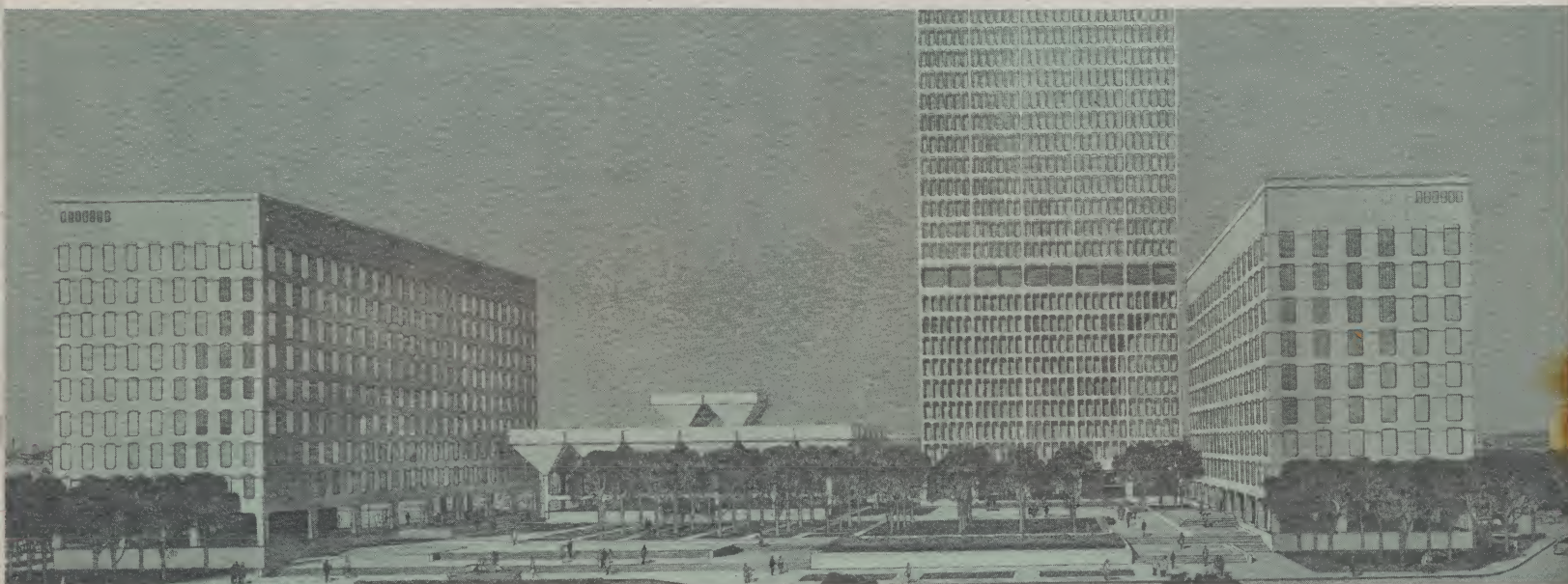
Styrene Mounting Board, FAST CLIP<sup>™</sup> connectors, and mounted components are provided so that circuits can be built in a minimum of assembly time.



12-Pin Jack allows students to construct circuits and then see how they perform in the trainer.



# HICKOK



*Located adjacent to Massachusetts Institute of Technology.*

## PROGRAM CONTENTS

### Course Material

Digital Computer Fundamentals Text  
Digital Computer Fundamentals Laboratory Manual

### Teacher Aids

Digital Computer Fundamentals Teacher's Guide  
Six 16 MM Color Instructional Films  
In-Service Workshops and Institutes

### Laboratory Equipment

Digital Computer Trainer

**HICKOK**

**TEACHING  
SYSTEMS**

545 Technology Square, Cambridge, Mass. 617/UN 8-5540  
*A Subsidiary of The Hickok Electrical Instrument Company*